THE PREVENTION AND MITIGATION OF FLOOD AND DROUGHT DISASTERS IN CHINA

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Flood and drought disasters take place frequently in China. During the era without systematic meteorological and hydrological data the records of flood and drought disaster were described in history books, local chronicles, steles, and other cultural relics. The Chinese people have made a long-time and unremitting struggle against flood and drought disasters. Since 1949, Chinese people under the leadership of the central government of China have launched water construction on a large scale, resulted with a flood control system and an agricultural irrigation system. These systems have played significant roles in protecting the development of society and country's economy. Along with the rapid growth of population and economy, however, many problems have emerged, such as the low standard of flood control projects, scarcity of water resources, soil erosion, water pollution and degradation of ecological environment. The disasters of flood and water-logging are still serious problems and scarcity of water resources becomes more and more constraints to the development of agriculture and social economy.

1. GENERAL SITUATION OF FLOOD AND DROUGHT DISASTERS

According to the historical records from 206 BC to 1949 AD, 1029 times of big floods and 1056 times of severe droughts occurred in China. Since 1949, the average annual area affected by floods and droughts is about 30 million ha, of which over 20 million ha is affected by droughts and 9.3 million ha by floods. The average area suffered a production loss more than 30% is about 13 million ha, of which over 8 million ha hit by droughts and 4.6 million ha by floods.

1.1 Floods

1.1.1 Types of flood disaster

Flood disasters, water-logging disasters, coastal storm surge disasters and disasters induced by alkalization are the common types in China. It is usually difficult to differ flood disasters and water-logging disasters; coastal storm surge disasters are often incorporated with flood disasters; disasters induced by alkalization are closely linked with water-logging. In China the most influential and serious disasters are those from flood, water-logging and coastal storm surge.

1.1.2 Characteristics of flood disasters

Serious floods mainly take place on the plains of the middle and lower reaches of the major rivers and coastal plains. These plains are of fertile soil and dense population, and with developed economy. Most of the elevations of these plains are lower than the flood levels of the rivers. Levees are the principal measure to protect these plains. Once the flood level is higher than the standard of flood control, the economic loss will be great. The inundated area and collapsed houses in the plain areas accounted for two thirds of the country.

1.1.3 Basic rule of flood disasters

Monsoon climate prevails in most areas of China. The rain belts that concentratively occur in summer run generally in east-west direction, moving gradually northwards. Serious flood disasters in normal years occur first in South China and gradually shift northward. In most years, the flood disasters are of scattered type. The big disastrous floods have certain periodicity and siminality. The losses valve by the disasters per unit area is increasing.

1.1.4 Statistics of flood disasters

In the last 50 years, the average annual area hit by floods was 9.3 million ha, among which 4.6 million ha were damage-stricken, accounting for 50% of the total. The average annual death toll was 5280 people and the average annual collapsed houses were 2.1 million rooms. Among the death toll, two thirds took place in the mountainous and hilly areas and one-third in the plain areas, where the occurrence of floods, landslides, debris flows was frequent. Among the collapsed houses, 40% occurred in the mountainous and hilly areas and 60% occurred in the plain areas.

1.2 Droughts

1.2.1 Types of droughts

Various types of droughts may occur in China, such as drought induced by scarcity of water resources, drought caused by lack of engineering projects, drought caused by water pollution and drought caused by mixed reasons. According to the affected objects, it can be classified as droughts in agricultural areas, droughts in pastures, difficulties in drinking water in rural areas, and water shortage in urban and industrial areas. As the area affected by droughts is quite large and the duration of drought is long, the effect of droughts on agriculture is most serious.

1.2.2 Characteristics of droughts

Droughts may happen anywhere in China. The most serious droughts occur in North China, western part of Northeast China, Loess Plateau and Northwest China. Droughts may appear in every season in a year. Historically, some droughts lasted several months, even several years. Drought occurred in a consecutive period from 1959 to 1961, resulted in the average annual area of 35 million ha hit by drought in more than 10 provinces, autonomous regions and metropolises, among which 14 million ha were seriously affected. In the last 50 years, 19 years suffered droughts in an area of 20% plus of the total territory (the seriously affected areas in an area of 10% plus of the total territory), spreading over 10 provinces, autonomous regions and metropolises; the probability of occurrence of drought was 38%.

1.2.3 Rules of droughts

The probability of occurrence of drought in the Haihe River, Huaihe River and Yellow River Basins is larger than that in the area along the middle and lower Yangtze River, South China, and coastal area in Southeast China. In the areas lying to the north of the Huaihe River, spring drought, summer drought and consecutive drought in spring and summer may occur while spring drought is the major one; in the area of the middle and lower Yangtze River summer drought and autumn drought may occur while summer drought is the major one; in

South China consecutive drought in summer and autumn may occur while the most serious droughts occurs in mid-summer; in the area of the upper Yangtze River and Southwest China consecutive drought in spring and summer may occur while spring drought is the major one. Drought may occur simultaneously in the Haihe River, Yellow River and Haihe River Basins. The probability of simultaneous occurrence of drought in the lower Yangtze River and Southeast China is higher than the former. A close relationship of occurrence of droughts in the Huaihe River Basin and the area of the middle Yangtze River exists.

1.2.4 Statistics of droughts

In the last 50 years, the average annual farmland area hit by drought was 20 million ha, among which 8 million ha were seriously damaged. The average annual reduction in food grain production was as large as 11 million tons. The annual reduction in grain production increased year by year.

1.3 Impact of flood and drought disasters

1.3.1 The impact on the people's life

China has a large population which is unevenly distributed and most of it is concentrated in the middle and lower reaches of the rivers where flood and water logging always occur. Serious flood and drought disasters may cause a large number of deaths and losses of property. Small part of the population lives in the mountainous areas, high lands, pasture areas and islands where droughts are the main constraints of the local economic development and the improvement of people life.

1.3.2 The impact on the social economy

The impact of the flood and drought disasters on China's social and economic development is still an outstanding problem. The average annual food grain output reduction caused by flood and draught disasters is 15-20 billion kg and the caused economic losses is increasing. According to the statistics, since the 1990's, the average annual economic losses by flood disasters was 100 billion Yuan RMB. In 1998, the economic losses by flood and water-logging disasters was 200 billion Yuan RMB.

1.3.3 Degradation of environment

Storm floods in the mountainous and hilly areas frequently induce serious soil loss, reduction in farmland, reduction in the thickness and fertility of the top soil. Floods in the plain areas inundate farmland, leading to deposition of coarse sediment particles, damage the river systems and lead to secondary alkalization. Many problems have induced by droughts, such as over-exploitation of surface water and ground water, cutting-off rivers, shrinkage of lakes and ponds, large amplitude depression of ground water surface, depression of earth surface, encroachment of sea water, and desertification. Due to water shortage, natural purification of sewage is difficult to carry out, leading to water pollution. Due to drought, temporary shortage of drinking water for 10 million people takes place each year mainly in the mountainous and hilly areas.

2. MAJOR CAUSES OF FLOOD AND DROUGH DISASTERS

The causes of flood and drought disasters are diverse, but the major causes are the

uneven distribution of water resources and poor infrastructure of prevention countermeasures. Some human activities also aggravate the disasters to some extent.

2.1 Uneven distribution of water resources

Precipitation is influenced by monsoon, topography, locality, etc. The temporal and regional distributions of precipitation in China vary significantly. The regional distribution of annual precipitation is descending from southeast to northwest. In coastal areas of Southeast China, the mean annual precipitation depths are higher than 1600 mm and in Northwest China, the mean annual precipitation depths are less than 50 mm. The mean annual precipitation depth in one half of the country is less than 400 mm. In the southern rainy areas, the annual precipitation in wet years is 1.5-3 times of that in dry years; in the northern areas, the former is 3-6 times of the latter. The monthly variation of precipitation is also quite significant. In most areas of the country, the total precipitation in 4 months with heavy rains accounts for 60%-80% of the annual precipitation. The water amount per capita of the country is 2300 cu m, but it is 168, 394, 387 and 398 cu m in Tianjin, Beijing, Hebei and Shandong provinces, respectively. The mean value of these four metropolises and provinces is less than that of Israel, showing the severity of water shortage.

2.2 Poor infrastructure of water conservancy and low standard of disaster prevention

The standard of flood control of the major rivers is only 10-year to 20-year flood without using the detention basins. When the detention basins are used, it increases to 20-year to 50-year flood. For medium and small rivers the standard of flood control is even lower. The safety measures in the detention basins are inadequate. For 70% of the cities the standard of flood control is lower than the national standard, there is almost no flood control measures in some cities. The safety standard of 30% of large and medium-sized reservoirs and 40% small reservoirs is lower than the national standard. 50% of sea walls have not reached the design standard. There are so many vulnerable spots along the levees of the major rivers. The irrigated farmland only accounts for 40% of the total, the rest is rain-fed farmland. Because of lack of facilities of diversion and withdrawal, one third of the irrigated farmland is susceptible to severe drought. The development of water saving measures in irrigation and other fields is slow.

2.3 Irrational human activities aggravating the disasters to some extent

Irrational human activities, such as excessive deforestation, destruction of vegetation, and cultivation on steep slopes lead to severe soil loss in the upper reaches of the rivers and significant deposition of sediment in the areas along the lower reaches of the rivers. The eroded area of the country is 3.67 million sq. km out of which 1.79 million sq. km is of the water eroded. The annual soil loss is 5 billion tons. Serious deposition of sediment takes place in reservoirs, lakes, and rivers, resulted in the reduction in their capacities. The flood carrying capacity of the tail reach of the Haihe River near Tianjin has reduced to 50% of the design value. Sediment deposition in lakes has given rise to reclamation. In the last 50 years, 11,000 sq. km land have been reclaimed in lakes along the middle and lower reaches of the Yangtze River, equivalent to an area of 4 Dongting Lake.

3. PREVENTION COUNTERMEASURES FOR FLOOD AND DROUGHT DISASTERS

For mitigating flood disasters and droughts it is necessary to make comprehensive planning and integrated management, make benefit and reduce disasters and control flood and

combat drought simultaneously. To further enforce the water infrastructure construction and minimize the losses caused by the disasters is an important strategic measure to guarantee the smooth development of the national economy, raise the people's living standard and maintain the social stability and sustainable development. It should be from the strategic point of view for by century development to strengthen education to the people to understand better on China's water issue, strengthen legislative construction, popularize the advanced and applicable science and technology, complete the relevant policies and set up stable input insuring systems.

3.1 Countermeasures for preventing and mitigating flood disasters

Flood control should pursue the principle of "combining storage and discharge and taking discharge as the key link" and carry out the comprehensive management. The integrated flood control system should be established by adopting the engineering measures such as construction of river embankments, reservoirs on the main course and tributaries of rivers, storage and detention basins and river management as well as non-engineering measures like water and soil conservation and eco-environmental protection.

3.1.1 Reinforcement of dykes

The dykes are the basis of the flood control engineering system which play a very important role in preventing and fighting against flood and water-logging disasters. At present, work on dyke construction and reinforcement should focus on heightening of unstandard lower sections, anti-seepage for foundation, treatment of the hidden danger of dyke body, backfilling of pits or ponds close to dykes, structures crossing dyke and reinforcement of joining points between structures and dykes body. The work should be carried out in steps according to the importance of dykes and the seriousness of dangerous conditions.

3.1.2 River course management

The river course management is an important measure to raise river's flood control capacity, stabilize river situation and safeguard dykes. The effective measures should be taken to protect those collapsed sections of river embankment. Dredging and obstacles cleaning should be undertaken in a planned way in the silted up flood lands which affect the flood water discharging so as to increase the discharging capacity of the river courses. In order to increase the discharge and storage capacity of rivers and lakes, those flood lands and platforms which seriously affect the flood water discharging and raise water level should be completely leveled.

3.1.3 Speeding up of construction of controlling projects for rivers

The construction of the key reservoirs controlling rivers and having functions of stopping floods and cutting flood peaks should be accelerated: to seize time for projects under construction in order to produce flood control benefits; to speed up the work on reinforcement of weak and dangerous reservoirs so as top get rid of big hidden danger for flood control projects; to adjust the comprehensive functions of the reservoirs in operation and, if possible or necessary actions need to be taken, increase storage capacity for flood control benefits; to constructure in a planned way some new big size reservoirs such as Nierji project on the Nengjiang River, Baise project on Youjiang River, Longtan project on hongshui River, Zhaosi project on Lishui River, Shuibuya project on Qingjiang River and Zipingpu project on Minjiang River, etc. In order to gradually raise the comprehensive flood control capacity of the rivers.

3.1.4 Strengthening construction of storage and detention basins

In order to protect safety of the key flood control areas, it is an effective measure to reduce losses from flood and water-logging disasters by means of setting up storage and detention basin with certain capacity at appropriate areas to store or discharge excess flood water taking into account the high flood peak, big flood water amount and limited discharging capacity. For those flat lands where storage and detention basins are to be built, it is necessary to strengthen the construction of safety structures in order to store or discharge flood water.

3.1.5 Strengthening of water and soil conservation and eco-environmental construction

Water and soil conservation is an important measure for river management, the major project of the eco-environmental construction and one of the basic policies of the country. Chinese government requests: a. from now and on, any actions of damaging forests should be absolutely stopped; b. The farming lands on slopes of over 25°should be put back for forests; c. The farming lands on slopes of less than 25°shall be reformed into terraced lands; d. taking small watersheds as units and having an overall planning for hills, water, farmlands, forests and grass, comprehensive management should be carried out by combining the engineering, biological and farming measures; e. the new water and soil erosion caused by human activities should be firmly controlled; f. 50,000 sq. Km of soil erosion area should be put under control each year.

3.1.6 Strengthening of construction of non-engineering flood control system

a. The legislative work for water management should be strengthened. The flood control of rivers and lakes is related to the areas in the upper and lower reaches and at both banks of the rivers and lakes and involves the benefits of the relevant sectors such as flood and water-logging control, power production, navigation, sand mining and reclamation, etc. Therefore, there will be some contradictions resulted. To solve these problems, it should rely on the laws and regulations. The work on modifying the water law and formulating the supplementary regulations and rules to the Flood Control Law should be promoted. It is more urgent to work out the compensation method for using flood storage and detention basins and the flood insurance system. At the same time, the formulation of other relevant regulations and rules and supervision on law implementation should also be speeded up.

b. The state flood control commanding system should soon be established. At present, generally, the forecasting system for rainfall, water status of project and disasters is rather backward and the information can not be received in time. Therefore, they can not meet the demand of flood control and fighting against disasters. In the next 3 to 5 years, in the principle of overall planning and unified standard, construction of flood control commanding systems at central, river commissions, provincial, prefecture and county levels should be carried out so as to prolong the forecasting period and raise the scientific level of flood control commanding and decision-making.

c. The planing for river management must be well conducted. The river management and development is based on the planning of water resources. Along with economic development and the changes of water, river and project conditions and the society, the original plans need to be modified considering the new practical situations. When modifying, it should consider all relevant factors better coordinate the relations between benefits generating and disaster mitigating, between selling temporary relief and fundamental relief, between flood control and drought relief, between human being and nature, between economic development and land

reclamation/water environment. Only in this way can the plans for management and development be scientifically reasonable and effectively implemented.

d. Strengthening of scientific research and technical supervision work for river management. The experience of 1998 big flood shows that there are still many issues that need to be studied thoroughly on flood control of rivers, such as difference of timing and space of storm rain floods, the impact of change river basins' ecology over flood, river-lake relation, water-sediment relation, river course changing, flood water dispatching, survey of hidden danger of dykes, quick treatment of emergency, flood control criteria, flood insurance, risk analysis, disaster assessment, information release and decision-making support, etc. By doing so, the important roles of science and technology over river management will be fully played. Meanwhile, the technical supervision should also be strengthened, all responsibility systems implemented, supervision of project construction enforced and the project quality ensured.

e. Strengthening of flood control project management. The project management should be an important measure to raise the integrated flood control capacity and reduce losses from disaster. It should particularly enforce the management for dykes, river courses, reservoirs, storage and detention basins and river basins' eco-environment so as to improve the comprehensive prevention ability of the flood control system and reduce losses resulted.

3.2 Countermeasure for preventing and mitigating drought disasters

One of the important reasons of drought in China is the uneven distribution rainfall in time and space and that the distribution of water and land resources is not harmonious with the population. The contradiction between water demand and supply will exist in the long time. Therefore, when studying and solving water shortage and drought problems, the principle of combining exploitation of new sources and water-saving should be seriously pursued and the management for water demand and supply be further strengthened.

3.2.1 To carry out an all-round water-saving movement

The biggest water consumer in China is agriculture. The Chinese Government requests that the spreading of water-saving irrigation technology should be taken as a revolutionary measure. The agricultural water-saving should be focussed on the control over flood-irrigation to reduce non-effective evaporation, losses from seepage, water-consumption per unit production and amount of sewage discharge and raise the rate of water reuse. In the cities and towns, the use of water-saving type devices in daily life should be encouraged to minimize the waste of domestic water and it should promote the development of the water-saving society and the effective treatment on water-shortage problem.

3.2.2 The rational utilization of local water resources

For most of the dry areas, all kinds of engineering and non-engineering measures should be adopted to solve the water-shortage problem and rationally develop and utilize the local water resources.

a. The overall planning and dispatching and reasonable allocation of water from rivers, lakes and reservoirs as well as ground water should be implemented;
b. The use of rain-water. For the arid and semi-arid areas, the rain-water collecting projects should be constructed to store the rain-water during the raining season for daily-life use and supplementary irrigation use;
c. The reuse of waste water. In the urban and industrial areas, the large amount of waste water

should be properly treated and discharged according to the required criteria and for agricultural and environmental uses so as to make the waste water new resources.

d. The use of light salty water. In the northern coastal areas and the northwestern inland areas, there is large amount of light salty water which can be used. According to the needs for crops and plants, the alternative use of fresh water and light salty water can help ease the situation of local fresh water shortages;

e. The use of sea water. China has a long coastal line. In the coastal areas, large amount of sea water can be used as cooling water for industries. The sea water can also be desalted to replace fresh water in order to solve the local fresh water shortage problem.

3.3.3 To optimize the distribution of water resources

In developing and utilizing water resources, the principle of coordinating the development of resources, environment and economy with the population should be insisted and water will then be supplied to the uses reasonably. The optimized distribution of water resources can guide, restrain and limit the adjustment and regional set up of the industrial water uses. It is especially in the arid and semi-arid areas that the approval of industrial set ups and land resources development should be based on the water resources distribution.

3.3.4 To exploit new water sources in the long term

In the northern water-shortage areas facing serious water-shortage problem even after rationally using local water resources, carrying out water-saving campaign and raising water utilization efficiency, new water sources should be exploited. The studies on diverting water from neighboring rivers may be carried out. The feasibility studies, overall planning and verification and scientific optimization should be conducted for the construction of trans-basin water transfer projects.

3.3.5 Strengthening of the integrated management of water resources

With the increase of scale of water supply projects and water consumption, the unified comprehensive management and management by different regions and at different regions and at different levels are needed since this is a complicated system project involving multi-water sources and sectoral agencies. The water management should focus on the formulation of laws and rules which are basis for better water management, utilization and protection. The extensive management of water should be changed toward intensive management and the social beneficial development model toward the market-oriented. The sustainable utilization of water resources in China can be achieved only when the limited resources are better protected and managed.

3.3.6 Speeding up the establishment of the drought information system

Timely receiving of drought information of the whole country serves the important basis for guiding the prevention and mitigation of drought disasters. The systems of drought assessment and of drought monitoring, data collecting, transmitting, analysing and assessing and decision-making should be established based on the existing drought forecasting system in order to timely and accurately receive information on drought, make decisions for disaster prevention and mitigation and reduce the losses from disasters.